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DEMONSTRATION OF REPLICABLE DIMENSIONS OF HEALTH BEHAVIORS*

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SUMMARY

Appropriate health behaviors are necessary to ensure health and well-being, thereby keeping military personnel ready to perform their jobs which may demand exceptional efforts at key times. An understanding of factors influencing health behaviors would be more readily achieved if general dimensions could be identified to delineate sets of health behaviors that consistently co-occur. Such dimensions may represent the effects of causal factors influencing multiple behaviors and may, thereby, provide an empirical basis for identifying causal factors that have widespread behavioral effects. Modifying these causal factors may be an efficient way to improve health behavior. Well-defined health behavior dimensions are a requirement for these undertakings, but such dimensions have not been established. Prior research has suffered from the use of only brief lists of health behaviors, failure to systematically select health behaviors to represent hypothesized health behavior dimensions, and failure to replicate findings across samples.

The present study was designed to extend prior efforts by determining the number of dimensions of health behavior that could be reliably identified in two samples of Navy personnel. A set of 40 health behavior items was chosen to represent four major dimensions of health behavior that prior work suggested were present in groups representing a wide range of social and demographic backgrounds.

One sample of participants consisted of 812 men assigned to duty on U.S. Navy ships during 1984 who volunteered to participate in a survey study of general health habits conducted as part of program evaluation efforts for the Navy's Health and Physical Readiness Program. A second sample consisted of 605 recruits participating in a study of the effects of different interventions to stop smoking in Navy basic training. Data on the 40 health behaviors were collected by self-report questionnaires. Principle components analysis was conducted with 2, 3, 4, and 5 components extracted in each sample. The stability of the solutions across samples was determined by computing coefficients of congruence, by cross-validating regression weights for the factor scores, and by determining the number of items with component loadings greater than .30 in both samples. Different solutions also were compared in terms of the number of items that could be assigned to at least one component and how many of these were assigned to just a single component.

The 2-component solution was the most stable across samples, but the 3- and 4-component solutions also were reasonably stable. Further consideration of the associations between the different solutions suggested that there were two general dimensions, each comprised of more specific subsets of behaviors. One general dimension was comprised of preventive health behaviors that encompassed two specific dimensions of wellness maintenance behaviors and accident control behaviors. The second general dimension was comprised of risk taking behaviors with two specific dimensions of traffic-related risk taking and use of potentially harmful substances (e.g., alcohol, cigarettes). Brief scales for the four specific dimensions were proposed which had acceptable internal consistency coefficients and were only moderately intercorrelated in the two primary samples and in two smaller samples which had completed the health behavior checklist for other research purposes.

The proposed hierarchical model provides a framework for conceptualizing and measuring health behaviors to determine their antecedents. Indeed, one important aspect of the hierarchical model is that it implies the existence of causal factors with different ranges of effect. The most general dimensions imply the existence of some causal factors with relatively broad ranges of effects, while the more specific factors imply the existence of other causal factors with effects limited to a few behaviors. Identifying the antecedents of these behavioral dimensions should help define potential targets for behavior modification programs and permit evaluations of those programs in terms of the full range of behaviors that the programs can be expected to influence. This latter point is critical to program planning and evaluation for health promotion.

INTRODUCTION

Health behaviors can be broadly defined as actions undertaken to maintain or improve health (Kasl & Cobb, 1966). One issue in health behavior research is whether such behaviors must be considered individually or can be grouped into general categories to better understand them. It has been demonstrated repeatedly that health behaviors tend to co-occur and that between 2 and 5 dimensions or clusters are needed to summarize the empirical patterns of association between behaviors (Williams & Wechsler, 1972, 1973; Harris & Guten, 1979; Langlie, 1977, 1979; Tapp & Goldenthal, 1982; Vickers & Hervig, 1984; McCarthy & Brown, 1985; Norman, 1985; Kannas, 1981; Steele & McBroom, 1972). While it is reasonable to regard the presence of multiple categories of co-occurring health behaviors as well established, there presently is no consensus regarding the number or precise content of the categories required to describe these behaviors. The present study was undertaken to help resolve these issues by determining the number of replicable dimensions of health behavior in two large samples of young men.

The conclusion that health behavior is multidimensional has important implications for the conceptualization, measurement, and modification of health behavior. Conceptually, multidimensionality means that health behaviors are neither monolithic nor independent. Instead, theoretical models must incorporate intermediate concepts that encompass multiple behaviors, but do not attempt to treat health behavior as a monolithic entity. From a measurement perspective, the implication is that multi-item measures are feasible. However, it is necessary to define the domains of each concept, clearly defining the referent behaviors as a basis for defining observations that can be used for measurement. The behavior modification implications are linked to the assumption that behaviors which co-occur regularly share some common causes, while the differentiation of behaviors into multiple categories implies differences in causes across dimensions. If so, well-defined categories will provide a basis for more effective attempts to identify manipulable antecedents of health behaviors, thereby providing a better basis for choosing the targets of interventions.

The most critical problem preventing health researchers from realizing the benefits of multidimensional models of health behavior is the inconclusive nature of the evidence regarding the number of dimensions to be considered. To date, the typical study has not systematically sampled hypothesized categories or dimensions of health behavior, has involved only a few health behaviors, and has not verified the replicability of the factor or category structure demonstrated. Although there are isolated instances of studies that involved large numbers of behaviors (Williams & Wechsler, 1972, 1973; Vickers & Hervig, 1984), systematic sampling from a defined conceptual domain (Langlie, 1977), and systematic replication across samples (Norman, 1985), the authors are unaware of any available study combining these attributes.

The present study was designed to further health behavior research by providing additional information regarding potential benchmark dimensions for health behavior. Forty health behaviors were selected to represent four major empirical categories of health behavior described by Vickers and Hervig (1984). Broadly speaking, the categories represented (a) behaviors which reduce the risk of overtaxing the body's adaptive capacity, (b) behaviors which involve risk taking, primarily as a pedestrian or driver, (c) behaviors which should help prevent the onset of illness, and (d) behaviors which might improve health rather than merely prevent illness. These categories were not necessarily expected to exhaust the important components of health behavior, but they did provide a framework for sampling health behaviors that was sufficiently general to encompass the majority of behavioral groupings suggested by prior research.

METHOD

Sample

Two samples of Navy personnel completed health behavior checklists voluntarily after receiving descriptions of research studies which included these lists as part of more general research designs. The first sample consisted of 812 men assigned to duty aboard Navy ships. The typical respondent in this sample was 25.9 (S.D. = 6.0; range = 18-50) years of age. The primary ethnic groups were Caucasians (79.1%), Blacks (8.9%), Malayans/Filipinos (5.9%) and Hispanics (4.7%). Nearly all of the participants had 12 years (68.4%) or more (25.4%) of formal schooling. Enlisted personnel comprised 92.9% of the sample and officers 7.1%. The average length of service at the time of the survey was 6.0 (S.D. = 5.5) years.

The second sample consisted of 605 male Navy recruits who completed the health behavior checklist at the beginning of basic training. The typical respondent in this sample was 18.8 (S.D. = 2.3, range=16-35) years of age. The primary ethnic groups were Caucasians (67%), Blacks (19%), and Hispanics (8%). Nearly all of the participants had a high school diploma (82%) or Graduate Equivalency Diploma (4%).

Health Behavior Checklist

The 40 items chosen to represent the four health behavior domains defined in the Introduction are presented in Appendix A. Each respondent was asked to indicate how well the specific health behaviors described his typical behavior. In the shipboard sample, response options were on a continuum from "Not at all like me" (scored 1) to "Very much like me" (scored 5). In the recruit sample, response options were on a continuum from "Disagree strongly" (scored 1) to "Agree strongly" (Scored 5).

Analysis Procedures

Principal components analysis was employed to determine the dimensionality of the health behaviors. Analyses were conducted extracting 2, 3, 4, and 5 components for each sample. This range of solutions was chosen on the basis of prior evidence that between 2 and 5 dimensions should be adequate to represent health behaviors. After extraction, component loadings were determined from an orthogonal varimax rotation.

The first analysis concern was determination of the number of replicable dimensions of health behavior. The replicability of the component structure across samples was determined first by computing coefficients of congruence (Gorsuch, 1974). Components were matched across the samples by constructing a table with rows defined by the components of the given solution (i.e., 2-, 3-, 4-, or 5-component solution) for the shipboard sample and columns defined by the components of the recruit sample. The table entries were the coefficients of congruence for the pairs of components defined by the row-column combination. The matching procedure first identified the pair of components with the largest coefficient of congruence. Those two components were considered a match and a reduced table was constructed by deleting that row representing the shipboard component and the column representing that recruit component. The procedure was repeated with the reduced table until all factors had been matched. This procedure was applied to the 2-, 3-, and 4-component solutions, but in the 5-component solution, the second largest coefficient of congruence had to be chosen for one component to provide a better overall match for the full set of components (see Results).

Two additional methods of comparing component solutions were used to confirm the component matching based on the coefficients of congruence. The similarity index (Cattell, Balcar, Horn & Nesselroade, 1969) was one addition. This index is computed by specifying an absolute value for component loadings that determines whether or not an item is salient to that component. In the present application, there were no components which had both positive and negative salient items, so components defined by large negative loadings were reflected and all salient loadings were greater than zero. Under these conditions, the similarity index is the ratio of the number of items salient to both components divided by the total number of items salient to at least one of the components being compared. Thus, the similarity index would reach a maximum value of 1.00 when exactly the same items were salient to both components and a minimum value of .00 when there was no overlap in the sets of salient items. In this study, the similarity index was computed twice, once with .30 as the criterion and once with .45 as the criterion, to evaluate the effect of criterion choice on estimates of similarity (Walkey, 1986). The number of items salient for the components being compared is presented in the results to indicate the number of salience matches contributing to the similarity index and as a guide to the number of items which might be considered as potential elements of scales to represent the component.

The preceding tests describe the replicability of the component solutions in terms of the location of health behavior <u>items</u> in component space. A fourth replicability estimate was provided by computations based on the location of <u>individuals</u> in the component space. The factor score regression coefficients were obtained for each component analysis in each sample. These regression weights then were applied to the standardized item scores within each sample to provide two sets of linear composites. One set of composites represented estimated component scores for the sample obtained by applying the regression weights derived in that sample to the data for that sample (e.g., shipboard weights applied to the data of the shipboard sample); the second set of linear composites represented estimated component scores obtained applying the regression weights derived in the other sample (e.g., recruit weights applied to the data of the shipboard sample). The correlations between the two sets of composites then were computed within each sample to determine how similar the scores produced by the two sets of weights were. If the matched factors defined by the coefficients of congruence produced very similar regression weights for the computation of factor scores, these "cross-validation" coefficients would be close to 1.00 (Everett, 1983).

The second analysis concern was the definition of behavior composites that could be used as marker variables to represent the replicable health behavior dimensions. This concern directed attention to the identification of specific behavioral instances which could be employed to represent those dimensions. Identification of specific behaviors as representative of a given component was based on an average weighted component loading of .45 or more with a loading of .30 or greater in both samples, provided that the item met these criteria for only a single component.

RESULTS

Component Replication Analyses

On the whole, the 2-component solution was the most replicable across the two samples (Table 1), but there was no clear failure to match components until the 5-component solution was reached. Even for the 5-component solution, it was possible to match components so that the various replication coefficients were comparable in magnitude to those obtained in the 3- and 4-component solutions. However, Table 1 does not show the close similarity of shipboard component 4 and the recruit component 2 in the 5-component solution. The coefficient of congruence for this pairing was .77 with cross-validation correlations of .69 and .61 and similarity coefficients of .48 and .55. These values were larger than those obtained matching shipboard component 2 with recruit component 2 as shown in Table 1. However, if shipboard component 4 had been matched with recruit component 2, then shipboard component 2 would have been matched with recruit component 4. This match would have produced a low coefficient of congruence (.36), low cross-validation correlations (.10 and .20 for the shipboard and recruit samples, respectively), and low similarity indices (.08 and .00, for the low and high criteria, respectively). The combined implication of these statistics was that shipboard component 4 was the best match for two recruit

Table 1

Component Matching Statistics

Matched Components S - R	Congruence Coefficient	Regression Cross-Validation S	R	Similarity Index for Salience L	H	Number of Reliably Salient Items L	H
2-Component							
1 - 1	.97	.98	.97	.89	.71	24	10
2 - 2	.88	.92	.91	.73	.80	11	8
3-Component							
1 - 3	.78	.78	.65	.48	.27	8	2
2 - 1	.87	.78	.77	.61	.29	11	2
3 - 2	.95	.98	.98	.82	.75	8	6
4-Component							
1 - 2	.85	.84	.76	.71	.50	11	4
2 - 1	.88	.83	.78	.67	.73	8	4
3 - 3	.90	.92	.91	.80	.92	7	6
4 - 4	.70	.57	.61	.53	.00	4	0
5-Component							
1 - 1	.89	.82	.78	.73	.63	11	5
2 - 2	.72	.52	.54	.59	.17	8	1
3 - 3	.89	.90	.89	.89	.92	8	6
4 - 4	.76	.74	.65	.63	.36	6	2
5 - 5	.63	.61	.66	.55	.86	3	3

NOTE: "S" indicates results obtained with Navy shipboard personnel and "R" indicates results obtained with Navy recruits. "L" indicates results obtained with the salience criterion for a variable set at .30 (absolute) and "H" indicates results obtained with the salience criterion set at .45 (absolute). See Methods, page 4, for a description of the similarity index and number of salient items.

components. Therefore, it was clearly impossible to provide a well-defined, unequivocal matching between the samples for the 5-component solution. The two samples, therefore, were considered to have produced non-replicated component structures in the 5-component solution, so subsequent analysis and interpretation considered only the 2- through 4-component solutions, none of which had similar problems.

Although the two-component solution was the most replicable, the 2- and 4-component solutions presented in Table 2 illustrate the observation that the different solutions can be conceptualized as hierarchically related.

Components 4A and 4B clearly were comprised of subsets of the behaviors defining component 2A. Component 4C clearly was part of Component 2B. Finally, 4 of 5 items with weighted average loadings greater than .40 on Component 4D had their largest loading on Component 2B.

The replicability of the health behavior components also was estimated by comparing the present 4-component solution to that reported by Vickers and Hervig (1984). Coefficients of congruence were computed based on the component loadings for the 34 items common to the two studies. Approximate matches for the shipboard sample were: Component 4A - Vickers & Hervig (V&H) Component 4 (.81); Component 4B - V&H Component 3 (-.84); Component 4C - V&H Component 2 (.68); Component 4D - V&H Component 2 (-.67) or V&H Component 1 (.52). Approximate matches for the recruit sample were: Component 4A - V&H Component 3 (-.75) or V&H component 1 (.70); Component 4B - V&H Component 3 (-.59) or V&H Component 4 (.66); Component 4C with V&H Component 2 (.80); Component 4D with V&H component 4 (.74).

Table 2

Averaged Component Loadings for Health Behaviors:

2- and 4-Component Solutions

Solution:	2-Component		4-Component			
Component:	2A	2B	4A	4B	4C	4D
Preventive Habits						
(a) Wellness Behaviors						
14 Exercise#	.61*	.05	.16	.53*	.05	.31
31 Hlth Info#	.55*	.15	.18	.50*	-.10	.21
8 Reg Check#	.55*	.16	.28	.55*	-.17	.00
22 Dent Check#	.55*	.04	.18	.61*	-.07	-.04
30 Disc Hlth#	.53*	.09	.15	.50*	-.05	.20
23 Limit Food#	.53*	.11	.16	.47*	-.05	.25
32 Floss#	.50*	.03	.21	.50*	-.03	.04
11 Weight#	.50*	.11	.13	.46*	-.04	.25
25 Vitamins#	.47*	-.11	.02	.56*	.08	.03
1 Diet	.46*	.09	.30	.32	.01	.15
35 Food Suppl#	.45*	-.14	-.07	.57*	.12	.10
20 Avoid Germs	.45*	.30	.24	.32	-.21	.30
29 Avoid Poll	.42*	.19	.23	.23	-.02	.43*
37 Inoculation	.39*	.12	.28	.36*	-.12	-.08
34 Brush Teeth	.38*	.00	.17	.32	.05	.10
24 Avoid OTC Med	.37*	.12	.18	.30	-.03	.22
9 Religion	.35	.27	.10	.31	-.19	.29

Table 2 Continued

Averaged Component Loadings for Health Behaviors:

2- and 4-Component Solutions

	Solution:	2-Component		4-Component			
	Component:	2A	2B	4A	4B	4C	4D
	(b) Accident Control						
3	Emerg Phone#	.34*	.25	.61*	.01	-.10	.14
7	Destroy Med#	.40*	.20	.57*	.09	-.07	.16
6	First Aid Kit#	.37*	.09	.56*	.10	.03	.06
19	Check Hazard#	.52*	.27	.56*	.23	-.16	.19
21	Fix Broken#	.50*	.08	.53*	.25	.00	.07
36	Know First Aid#	.44*	.00	.47*	.25	.07	-.03
13	Health Sign	.58*	.28	.42*	.40	-.21	.18
4	Relax	.31	.07	.41*	.07	.03	.05
	Risk Taking Habits						
	(a) Traffic-related Risks						
28	Cross Street#	-.04	-.60*	-.20	.01	.63*	-.02
38	Take Chances#	.24	-.58*	.11	.14	.62*	-.07
33	Drive Fast#	-.05	-.57*	-.01	-.11	.60*	-.10
5	Pedest Risk#	-.06	-.55*	-.14	-.07	.62*	.04
12	Traffic Rule#	.30	.55*	.28	.18	-.50*	.20
15	Stop Light#	.01	-.51*	-.14	.02	.57*	.06
40	Risky Hobbies#	.14	-.50*	.18	.02	.53*	-.15
	(b) Substance Use Risk						
26	Not Drink#	.14	.41*	.00	.05	-.23	.57*
18	Not Chem Subs#	.26	.35	.08	.14	-.17	.50*
39	Drink/Drive	-.08	-.53*	-.08	.01	.38*	-.43*
16	Avoid Crime	.21	.43*	.21	.04	-.30	.34
	Miscellaneous Items						
17	Do Not Smoke#	.16	.19	-.19	.15	-.03	.55*
2	Get Sleep	.29	.16	.27	.14	-.08	.12
27	Seat Belt	.35*	.39*	.24	.25	-.29	.28
10	Avoid Chills	.40	.32	.29	.27	-.26	.18

NOTE: Table entries are weighted averages of the component loadings for the two samples computed using sample sizes as the weights. Numbers at the left margin indicate item numbers as they appear in the complete checklist (See Appendix A). "*" indicates that the component loading was greater than .30 in both samples. "#" indicates an item used in the proposed health behavior composites.

Analyses of Proposed Marker Variable Composites

Item composites to represent the four replicable dimensions of health behavior were constructed by averaging responses to items with weighted average pattern loadings of .45 or greater for each component in the 4-component solution (see Table 2). These composites have been given labels that reflect what appears to be their primary behavioral content, based on both the specific behaviors involved and their association to the more general dimensions defined by the 2-component solution. It is important to emphasize that these labels are used to simplify communication and should be regarded as hypothetical interpretations of the dimensions that must be confirmed by further research before they can become well-defined theoretical constructs. The item responses have been combined so that a high score indicates frequent occurrence of the given behaviors (e.g., high Substance Risks scores indicate frequent use of the substances listed).

These health behavior composites provided suitable marker scales for the replicable health behavior dimensions. Each scale had moderate internal consistency, but the values can be viewed as acceptable given the brevity of the scales (Appendix B). Also, the patterns of intercorrelations clearly indicated the tendency for Wellness Behavior and Accident Control to covary and for both of these scales to have substantially lower correlations to Traffic Risks and Substance Risks (Table 3). The correlations between Traffic Risks and Substance Risks were substantially smaller than those between Wellness Behavior and Accident Control.

The analysis of composites defined on the basis of factor analyses performed in the same sample are not necessarily representative of what can be expected in new samples. When analyses are conducted in the sample which has been factor analyzed, the results of the factor analysis imply substantial reliability. Whether these findings will generalize to other samples must be empirically determined, so it was desirable to determine how well the present findings generalized to independent samples. Thus, data on the 40 health behaviors available in two smaller, independent samples were analyzed to determine how well the findings would generalize. The first sample consisted of male Navy recruits (n = 116) with an average age of [illegible] (S.D. = 2.8, range = 17-32) years. The primary ethnic groups were Caucasians (77%), Blacks (14%) and Hispanics (5%). This sample was relatively highly educated for their age as 96% had high school diplomas and an additional 1% had Graduate Equivalence Diplomas. The second sample consisted of male Marine Corps personnel going through cold weather training (n = 95) who completed the health behavior questionnaire. The typical respondent in this sample was 21.9 (S.D. = 3.7, range = 18-39) years of age. The primary ethnic groups were Caucasians (68%), Blacks (16%), and Hispanics (7%). The large majority of the respondents had 12 years (83%) or more (9%) of formal education. Most of the men were enlisted (95%) with a median of 24 months of service (range 5 months - 17 years).

Descriptive statistics for the proposed marker composites were computed for these additional samples (Table 3). The resulting internal consistency estimates, mean scores, and patterns of correlation were broadly similar to those in the development samples.

Table 3

Descriptive Statistics for Proposed Scales

				Inter-scale correlations		
	Mean	S.D.	Alpha	(1)	(2)	(3)
Shipboard Sample (n = 812)						
(1) Wellness	2.87	.77	.82			
(2) Accident Control	3.41	.84	.73	.42		
(3) Traffic Risks	2.70	.78	.75	-.12	-.20	
(4) Substance Risks	3.03	1.08	.48	-.31	-.15	.14
Recruit Sample 1 (n = 605)						
(1) Wellness	2.81	.75	.74			
(2) Accident Control	3.33	.84	.64	.42		
(3) Traffic Risks	3.09	.78	.67	-.20	-.13	
(4) Substance Risks	3.41	1.19	.61	-.21	-.08	.32
Recruit Sample 2 (n = 103-116)						
(1) Wellness	2.92	.70	.74			
(2) Accident Control	3.50	.74	.57	.49		
(3) Traffic Risks	3.35	.75	.74	-.17	-.14	
(4) Substance Risks	3.16	1.10	.46	-.08	-.05	.24
Marine Corps Sample (n = 95)						
(1) Wellness	3.12	.70	.78			
(2) Accident Control	3.33	.78	.67	.58		
(3) Traffic Risks	3.25	.70	.64	-.28	-.24	
(4) Substance Risks	3.00	1.01	.43	-.13	-.10	.29

DISCUSSION

This study added to the evidence that health behaviors are multidimensional. The primary extension of previous findings has been the demonstration that covariations of health behaviors have a replicable pattern, at least when studied in comparable samples, with 2 to 4 dimensions or categories needed to summarize the patterns of association. The content of the most specific categories can be interpreted as identifying sets of behaviors which are related to (a) maintenance and enhancement of well-being, (b) avoiding or minimizing the effects of accidents, (c) taking risks, primarily related to avoidable exposure to automotive or pedestrian hazards, and (d) consumption of substances which may adversely affect health (e.g., tobacco and alcohol). The first three behavior categories were well-defined in the present study, and the fourth is one of the most consistently replicated factors in prior studies of health behaviors (Harris & Guten, 1979; Norman, 1985; Kannas, 1981; Tapp & Goldenthal, 1982).

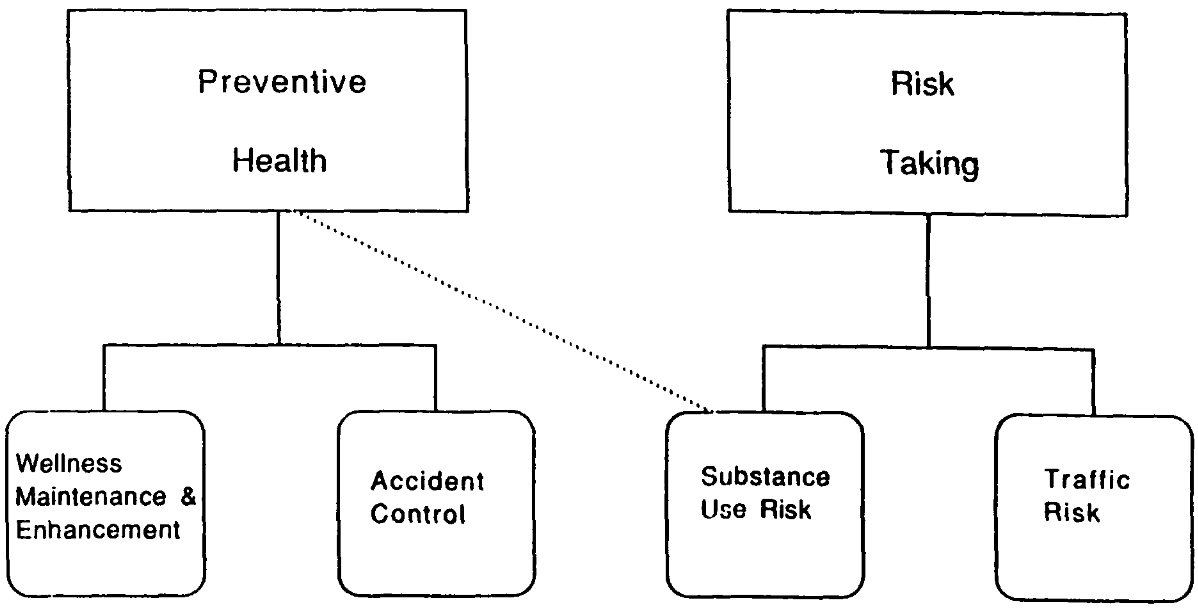
The replicability of the proposed dimensions of health behavior might be disputed on the basis of the weak matches to the four components identified in a prior study (Vickers & Hervig, 1984). However, this aspect of the findings must be evaluated in the context of differences between the two studies. These differences included not only the sampling of specific health behaviors (see pg. 7) but differences in response format (dichotomous versus 5-point Likert-scale) and component rotations (oblique versus orthogonal). Collectively, these differences could be expected to limit convergence across studies. The comparability of the results obtained with the proposed factor composites in two additional samples in the present study suggests that the present results will prove replicable, although this remains to be confirmed.

A conceptual interpretation of the replicable dimensions is provided in Figure 1. This figure embodies the assumption that health behavior dimensions are hierarchically organized. The broken line connecting Substance Use Risk to Wellness Behaviors is intended to indicate that Substance Use Risk is conceptually an element of Risk Taking, but empirically appears to be linked to Wellness Behavior as well.

It must be emphasized that Figure 1 represents a set of hypotheses which may be useful as a frame of reference for posing specific research questions for subsequent studies to better explore health behaviors. For example, is the assumption of a hierarchical model justified? What additional indicators can be used to improve the measurement of Substance Use Risk and, when such behaviors are considered, do the resulting measures produce stronger correlations between the hypothesized subcomponents of Risk Taking than observed with the present scales?

Figure 1

Proposed Hierarchical Model of Health Behaviors



One reason for proposing a hierarchical organization of health behaviors is that a hierarchical model can encompass proposals of general dimensions, such as Langlie's (1977) conceptual distinction between direct and indirect risk categories, and still accommodate evidence for more narrowly defined sets of specific behaviors, such as the clusters or dimensions identified by Vickers and Hervig (1984) or Harris and Guten (1979). At the same time, the hierarchical model explicitly poses the research problem of determining when general dimensions are appropriate and when specific dimensions are appropriate.

A second reason for suggesting a hierarchical organization of health behaviors is that this proposal has important implications regarding causal effects that give rise to the dimensions. From a causal perspective, behaviors covary because they share common cause(s). Thus, the two general dimensions of health behaviors presumably arise because some causal factors influence all the behaviors within, but not across, the two dimensions. Further, the general dimensions presumably contain more restricted subsets of interrelated behaviors, because additional causal factors exist which differentially affect behaviors within the two general dimensions. Verification of the prediction that differential patterns of causes are the basis for the observed dimensions is needed to demonstrate construct validity of the proposed conceptual model of health behaviors. Previous work provides reason to believe the two major dimensions have differential patterns of correlation to other variables (Langlie, 1979; Feldman & Mayhew, 1984), but a detailed comparison of the four dimensions has not been made.

Better definition of the behavioral scope of health behavior dimensions and delineation of antecedents of these dimensions may lead to re-evaluation of some proposed theoretical concepts in this area. The dimensions defined here are superficially consistent with some previous conceptualizations but differ in some important ways on closer examination. For example, the Wellness dimension and Traffic Risk dimensions are substantially similar to Langlie's (1977) distinction between indirect and direct risk behaviors. However, the present results suggest that both of her dimensions are specific subsets of more general dimensions which could imply very different conceptual interpretations than those proposed by Langlie (1979). Similarly, Kolbe's (1983, as cited in Green, 1984) distinction between wellness behaviors and preventive behaviors appears to be of limited empirical importance as representatives of both types of behavior appear to be elements of the Wellness Behavior dimension. In addition, his concept of "at risk" behavior might be extended to include everyday risks of accident and injury rather than referring only to illness and disease. If so, this category would require further definitional refinement to account for the presence of two empirical factors. As a general point, current conceptual models seem to emphasize the outcomes associated with health behaviors. While those outcomes are what make health behaviors important, consideration of the reasons for covariation of certain specific behaviors may provide alternative bases for conceptualization that will enrich our understanding of these behaviors.

The foregoing considerations have been suggested to illustrate that the proposed hierarchical model for health behaviors provides a potentially useful framework for additional research. Although appropriate caution must be taken when generalizing from the samples studied to populations with different socio-demographic attributes, the hierarchical model represents a set of related hypotheses which can be explicated and clearly tested in future research. One key problem for future research is to improve the delineation of the subcategories of health behaviors comprising the two general categories outlined here. The second major research problem posed by the proposed hierarchical model of health behavior is to identify plausible explanations for the covariances of behaviors that give rise to the proposed dimensions of health behaviors. The hierarchical model of health behavior presented here is one possible organizing framework for reviewing what is known about health behaviors and their antecedents and for conceptualizing and measuring health behaviors when addressing these two general research problems. It cannot be stated too strongly that the proposed hierarchical structure and the labelling of health behavior dimensions must be taken as tentative hypotheses to be tested in such studies. The proposed dimensions should not be taken at this time as well-defined, empirically validated theoretical constructs. However, the payoff from additional research designed to test the hierarchical model should be a better understanding of health behavior dimensions which will provide a stronger basis for programs to improve health and well-being -- even if the model ultimately proves inappropriate.

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Appendix A

Health Behavior Checklist

1. I eat a balanced diet.
2. I get enough sleep.
3. I keep emergency numbers near the phone.
4. I choose my spare time activities to help me relax.
5. I take chances when crossing the street, etc.
6. I have a first aid kit in my home.
7. I destroy old or unused medicines.
8. I see a doctor for regular checkups.
9. I pray or live by principles of religion.
10. I avoid getting chilled.
11. I watch my weight.
12. I carefully obey traffic rules so I won't have accidents.
13. I watch for possible signs of major health problems (e.g., cancer, hypertension, heart disease).
14. I exercise to stay healthy.
15. I cross the street against the stop light.
16. I avoid high crime areas.
17. I don't smoke.
18. I don't take chemical substances which might injure my health (e.g. food additives, drugs, stimulants).
19. I check the condition of electrical appliances, the car, etc. to avoid accidents.
20. I stay away from places where I might be exposed to germs.
21. I fix broken things around my home right away.
22. I see a dentist for regular checkups.
23. I limit my intake of foods like coffee, sugar, fats, etc.
24. I avoid over-the-counter medicines.
25. I take vitamins.
26. I do not drink alcohol.
27. I wear a seat belt when in a car.
28. I cross busy streets in the middle of the block.
29. I avoid areas with high pollution.
30. I discuss health with friends, neighbors, and relatives.
31. I gather information on things that affect my health by watching television and reading books, newspapers, or magazine articles.
32. I use dental floss regularly.
33. I speed while driving.
34. I brush my teeth regularly.
35. I take health food supplements (e.g. protein additives, wheat germ, bran, lecithin).
36. I learn first aid techniques.
37. I get shots to prevent illness.
38. I take more chances doing things than the average person.
39. I drink after driving.
40. I engage in activities or hobbies where accidents are possible (e.g. motorcycle riding, skiing, using power tools, sky or skin diving, hang-gliding, etc.).

Appendix B

Health Behavior Marker Scales

1. **Preventive Health Behaviors**

(a) Wellness Maintenance and Enhancement (10 items): average alpha = .77

14. I exercise to stay healthy.
31. I gather information on things that affect my health by watching television and reading books, newspapers, or magazine articles.
8. I see a doctor for regular checkups.
22. I see a dentist for regular checkups.
30. I discuss health with friends, neighbors, and relatives.
23. I limit my intake of foods like coffee, sugar, fats, etc.
32. I use dental floss regularly.
11. I watch my weight.
25. I take vitamins.
35. I take health food supplements (e.g. protein additives, wheat germ, bran, lecithin).

(b) Accident Control (6 items): average alpha = .65

3. I keep emergency numbers near the phone.
7. I destroy old or unused medicines.
6. I have a first aid kit in my home.
19. I check the condition of electrical appliances, the car, etc. to avoid accidents.
21. I fix broken things around my home right away.
36. I learn first aid techniques.

2. **Risk Taking Behavior**

(a) Traffic Risk (7 items): alpha = .70

28. I cross busy streets in the middle of the block.
38. I take more chances doing things than the average person.
33. I speed while driving.
5. I take chances when crossing the street.
12. I carefully obey traffic rules so I won't have accidents. [reverse scored]
15. I cross the street against the stop light.
40. I engage in activities or hobbies where accidents are possible (e.g. motorcycle riding, skiing, using power tools, sky or skin diving, hang-gliding, etc.).

(b) Substance Use Risk (3 items): alpha = .50

26. I do not drink alcohol. [reverse scored]
18. I don't take chemical substances which might injure my health (e.g. food additives, drugs, stimulants). [reverse scored]
17. I don't smoke. [reverse scored]

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Prior research has indicated that health behaviors are multidimensional, but the number of dimensions required to summarize the covariation between behaviors has not been firmly established. Problems with prior research include the use of small numbers of health behaviors, absence of selective choices of behaviors to permit comparisons across studies, failure to select items to represent hypothetical domains, and failure to explicitly replicate factor structures. The present study employed a list of 40 health behaviors selected to represent four theoretically important domains with an attempt to replicate the factor structures across two large samples (n = 605 and n = 812). A two-factor solution was the most stable across samples, but a four-factor solution was acceptable as well. It was suggested that the two solutions were hierarchically related with a higher order Preventive Health Behavior dimension comprised of subcomponents of Wellness Behaviors and Accident Control Behaviors. A higher-order Risk Taking Behavior dimension was suggested

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19(Cont). with subcomponents of Traffic Risk Taking and Substance Use. Scales for each dimension are proposed and the hierarchical model is suggested as a useful frame of reference for studies to verify the model, including identification of causal factors that can explain the behavioral covariations giving rise to the observed health behavior dimensions.